MEANS FOR ON-LINE DETERMINATION OF BOILING POINT PROPERTIES OF CRUDE OIL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to metering systems in general and, more particularly, to systems for determining boiling point properties of crude oil.

2. Description of the Prior Art

Heretofore boiling point properties of crude oil were determined by distillation tests which required samples to be taken and removed to a laboratory for determination. The present system differs by utilizing an empirically derived equation using four parameters of crude oil which may be analyzed on line so that an on-line boiling point determination can be made.

SUMMARY OF THE INVENTION

An on-line boiling point analyzer which provides a signal corresponding to a particular boiling point property of crude oil flowing in a line, includes analyzers sampling the crude oil and providing signals corresponding to the sulfur content, to the infrared absorption at a predetermined wavelength, to the ultraviolet absorption at another predetermined wavelength, and to the kinematic viscosity of the crude oil. A circuit provides the signal corresponding to the particular boiling point property of the crude oil in accordance with the signals from the analyzer.

The objects and advantages of the invention will appear more fully hereinafter, from a consideration of the detailed description which follows, taken together with the accompanying drawing wherein one embodiment is illustrated by way of example. It is to be expressly understood, however, that the drawing is for illustrative purposes only and is not to be construed as defining the limits of the invention.

DESCRIPTION OF THE DRAWING

The FIGURE shows crude oil being fed into a vacuum pipe still, shown in partial schematic form, being monitored by an on-line boiling point analyzer, constructed in accordance with the present invention, shown in block diagram form.

DESCRIPTION OF THE INVENTION

The following empirically derived equation may be utilized to determine a particular boiling point of crude oil:

$$M\%BP=\{-C_1+C_2[\ln(IR\times C_3)]+C_4(\ln UV)-C_5 S-C_6[\ln(IR\times C_3)](\ln UV)+C_7(IR\times C_3)]S\}\ln KV \qquad \text{(Eq. 1)}$$

where M%BP is a particular percent boiling point property, such as the 30% boiling point or the 50% boiling point, IR is the infrared absorption of the crude oil at a predetermined wavelength, S is the sulfur content of the crude oil, KV is the kinematic viscosity of the crude oil, UV is the ultraviolet absorption of the crude oil at a predetermined wavelength, and C_1 through C_7 are constants.

The particular percent boiling point to be determined by equation 1 is governed by the values of C_1 through C_7. The following Table relates the 30 and 50% boiling points to the values of the constants C_1 through C_7.

	30 % BP	50 % BP
C_1	1745.4246	3926.6512
C_2	525.6163	1129.0759
C_3	1000	1000
C_4	254.8026	541.8975
C_5	144.6291	278.5749
C_6	65.6417	141.0175
C_7	30.2110	69.0106

Referring now to FIG. 1, crude oil is being fed in a line 1 through a heater 3 to a vacuum pipe still 4. It is desirable in the operation of the vacuum pipe still 4 to know the boiling point properties of the crude oil in line 1. Samples are continually drawn off to line 7 and applied to a viscosity analyzer 9, an infrared analyzer 12, an ultraviolet analyzer 14 and a sulfur analyzer 15 which returns the samples through line 27 to line 1. Viscosity analyzer 9, infrared analyzer 12, ultraviolet analyzer 14, and sulfur analyzer 15 provide signal KV, corresponding to the kinematic viscosity of the crude oil corrected to 100° F, signal IR, corresponding to the infrared absorption of the crude oil at 6.27 microns, signal UV corresponding to the ultraviolet absorption of the crude oil at 269 microns, and signal S, corresponding to the sulfur content of the crude oil, respectively.

A source of direct current voltages (not shown) provides direct current voltages V_1 through V_{13}. Voltage V_1, corresponding to the term C_3 in equation 1, is multiplied with signal IR by a multiplier 20 to provide a signal to a conventional type natural log function generator 23. Function generator 23 provides a signal, corresponding to the term $\ln(IR\times C_3)$ to multipliers 28, 29. Multiplier 28 multiplies the signal from function generator 23 with the direct current voltage V_2, corresponding to the 30% boiling point constant 525.6163 (C_2 in equation 1) to provide a signal to summing means 33.

A multiplier 38 multiplies signal S with voltage V_3, corresponding to the 30% boiling point constant 144.6291 (C_5 in equation 1) to provide a signal to summing means 34.

Multiplier 29 multiplies the signal from function generator 23 with signal S to provide a signal, corresponding to $[\ln(IR\times C_3)]S$, to a multiplier 44. Multiplier 44 multiplies the signal from multiplier 29 with voltage V_4, corresponding to the 30% boiling point constant 30.2110 (C_7 in equation 1), to provide a product signal to a summing means 33.

Ultraviolet analyzer 14 provides signal UV to a natural log function generator 45 which provides a signal corresponding to ln(UV). A multiplier 46 multiplies the signal from generator 45 with voltage V_5, corresponding to the 30% boiling point constant 254.8026 (C_4 in equation 1) to provide a signal. Summing means 33 sums the signals from multipliers 28, 44 and 46, in effect summing the positive terms of equation 1, to provide a signal.

Multiplier 30 multiplies the signals from function generators 23, 45 to provide a signal to a multiplier 48 where it is multiplied with voltage V_6. Voltage V_6 corresponds to the 30% boiling point constant 65.6417 (C_6 in equation 1).

Summing means 34 in effect sums all the negative terms in equation 1 when it sums the signals from multipliers 38, 48 with voltage V_7, corresponding to the 30%